

March 9, 2007

U.S. Environmental Protection Agency, Region II  
Emergency and Remedial Response Division  
290 Broadway, 19th Floor, Room W-20  
New York, NY 10007-1866

Attention: Ms. Alice Yeh  
Remedial Project Manager

Subject: Comments to (1) *Preliminary Geochemical Evaluation Lower Passaic River Restoration Project, August 2005* and (2) *Draft Geochemical Evaluation (Step 2) Lower Passaic River Restoration Project, March 2006*.

Dear Ms. Yeh:

Tierra Solutions, Inc. [funding and performing, on behalf of Occidental Chemical Corporation] hereby submits comments pertaining to the above referenced documents. We hope these comments prove useful during development of the Focused Feasibility Study/Early Action Report, as well as to revision of these draft geochemical evaluations.

The following highlights some of the more significant observations from our review of these documents:

1. **The overall purpose, intent, and use of the information and analyses presented in the Lower Passaic River Restoration Project (LPRRP) Geochemical Evaluations (Preliminary and Step 2) are not clearly stated.** Section 1, *Introduction and Summary* of the Step 2 Geochemical Evaluation states that "*This geochemical evaluation presented in this document represents an important step in the on-going remedial investigation and feasibility study for the Lower Passaic River.*" In Section 6, *Conclusions and Observations*, the Step 2 Geochemical Evaluation states that "*These conclusions and observations should be viewed as important initial findings to be further explored and verified by the analysis of the fall 2005 data collection efforts as well as the ongoing modeling analyses.*" The Preliminary Geochemical Evaluation seems to imply that the results are going to be used to develop a Conceptual Site Model (CSM); however, the analysis of the fall 2005 data was completed **after** development of the draft LPRRP work plans. Therefore, it does not appear that the sampling plan for the low- and high-resolution coring programs was developed with the benefit of the fall 2005 data analysis. If one purpose of the Preliminary Geochemical Evaluation was to contribute to developing a CSM to guide characterization, the fall 2005 data analysis should have been performed prior to preparing the sampling plan.

It also is not clear how the data collected under the LPRRP, or the output of the fate and transport modeling analysis, will be incorporated into the various calculations and analyses presented in both the Geochemical Evaluations. Numerous analyses are performed, and associated conclusions drawn, in a haphazard manner and without proper justification. In addition, mass balances and volume/mass estimates of contaminated sediments were developed for the LPR. Taken together,



this suggests that the evaluations were developed primarily to support remedy evaluation/selection rather than development of the CSM.

Defining the objectives of the analyses is of critical importance. Understanding why and how the information is to be used determines how conservative the analyses should be, as well as how uncertainty should be treated.

2. **Uncertainty, and its effect on the calculations presented, has not been documented.** There is significant uncertainty (not all of which has been quantified by the authors of the Geochemical Evaluations [Malcolm Pirnie]) in the calculations associated with the volume of contaminated sediments and the contaminant mass balances. Unless the uncertainty associated with these simple calculations is quantified, they have little value or utility in the decision-making process. The simplistic nature of the calculations makes it very easy to spread the inherent uncertainty to the results. The uncertainty must be properly acknowledged and reasonably quantified. Due to the significant uncertainty associated with these calculations, conclusions cannot be reasonably drawn, stated, or defended.
3. **Data have not been evaluated with regard to the geomorphology of a meandering river/estuarine channel.** Site geomorphology was not considered in evaluating the spatial patterns and trends in sedimentation and contaminant profiles in the LPR. In the Step 2 Geochemical Evaluation, the authors state that "*Sediment deposition rates in Lower Passaic River (RM 0.9 to 7) have a high degree of spatial variability, varying from about -6 inch/year of erosion to about +8 inch/year of deposition over short distances.*" Bathymetric data show evidence of processes in the LPR that are consistent with expected geomorphology for meandering river/estuarine channels. Point-bar formations with thick accumulated sediment deposits occur along the inside bank at river bends, while deeper areas with limited sediment deposition occur at the outer bends (where the flow energy and turbulence are greater). Erickson et al. (2007) describes these geomorphic features (i.e., point-bars, river bends) within the LPR and discusses consistency of sediment deposition rates within the geomorphic features of the LPR. The spatial variability can be better understood by evaluating the data in the context of river geomorphology. Additionally, as discussed in Section 4.3 of the Step 2 Geochemical Evaluation, *Downcore Profiles and Contaminant History*, contaminant profiles have been preserved at depths corresponding to the peak historical loadings in depositional areas, further supporting the need for assessment of sedimentation in a geomorphic feature context. The Geochemical Evaluations should be re-visited to reassess the data based on channel geomorphology.
4. **Malcolm Pirnie establishes a conceptual model of the LPR based upon unsupported conclusions.** Malcolm Pirnie has used selected bathymetry comparisons and unconstrained calculations with a high degree of uncertainty to conclude that the LPR riverbed is highly responsive to extreme events, and that it is (and has been) the major source of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) contamination to Newark Bay. Such conclusions drawn from the analyses are carried forward without a clear acknowledgement of the

uncertainties. As a result, Malcolm Pirnie's conclusions are given undue credibility and present a biased picture of the processes within the river. This bias should be removed from the Geochemical Evaluations, and results of the assessment should be presented in a factual, balanced manner.

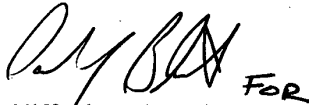
5. **The conclusions reached and the CSM established by the authors do not consider existing information maintained by USEPA regarding contaminant sources.** USEPA has a vast collection of documentation on many sources of many contaminants to the Lower Passaic River Study Area (LPRSA) and the Newark Bay Study Area (NBSA). Some sources are purely historical, some are ongoing today. The information and documentation has been compiled from publicly accessible resources through research conducted by Tierra and others, including information obtained through Federal Freedom of Information Act requests, State of New Jersey Open Public Records Act requests, literature searches, and interviews of knowledgeable persons. USEPA also may have additional information relevant to historical and ongoing sources of contaminants to the LPRSA and/or the NBSA that has not yet been made publicly available.

Numerous documents regarding contaminant sources to the LPRSA and NBSA have been submitted to and evaluated by USEPA, and made part of USEPA's ongoing enforcement strategy regarding Potentially Responsible Parties (PRPs). These include data regarding historic and ongoing sources of various hazardous substances, including, but not limited to, dioxins (and specifically, 2,3,7,8-TCDD), polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), and mercury. USEPA has utilized this information to notify PRPs regarding their liability for conditions in the LPRSA and/or NBSA through the issuance of General Notice Letters. Despite the existence of these data, the mass balance attempted in the Malcolm Pirnie CSM completely ignores these sources of hazardous substances while, at the same time, these hazardous substances are the focus of the mass balance presented. Additionally, and incredibly, numerous statements are made in the body of the Geochemical Evaluations regarding the lack of known, additional sources for these specific hazardous substances.

A. Yeh  
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and Draft Geochemical Evaluation (Step 2)  
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If you have any questions regarding the topics raised in this letter or the comments in the attached, please contact me at (757) 258-7720. We again want to express our appreciation for the opportunity to review these documents.

Sincerely,

A handwritten signature in black ink, appearing to read 'C. Firstenberg', with the word 'For' written in a smaller, cursive script to the right of the signature.

Clifford E. Firstenberg  
Project Manager  
On behalf of Occidental Chemical Corporation  
(as successor to Diamond Shamrock Chemicals Company)

Enclosure

- Comments on the Preliminary Geochemical Evaluation Lower Passaic River Restoration Project, August 2005 and the Draft Geochemical Evaluation (Step 2) Lower Passaic River Restoration Project, March 2006.

Copy to:

Lisa Baron, NJOMR  
Megan Grubb, USACE

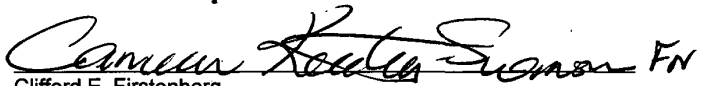
**Tierra Solutions, Inc.**

**Comments on the Lower Passaic  
River Restoration Project Draft  
Geochemical Evaluations**

Preliminary Geochemical Evaluation (August 2005) and  
Step 2 Geochemical Evaluation (March 2006)

March 2007

**ARCADIS** BBL

  
Clifford E. Firstenberg  
Project Manager

  
Paul J. Bluestein, P.E.  
Project Manager

**Comments on the Lower  
Passaic River Restoration  
Project Draft Geochemical  
Evaluations**

Preliminary Geochemical  
Evaluation (August 2005) and  
Step 2 Geochemical Evaluation  
(March 2006)

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Our Ref.:  
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Date:  
March 2007

**R2-0008269**

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## **Introduction**

Preliminary Geochemical  
Evaluation (August 2005) and  
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This document presents comments of Tierra Solutions, Inc. (Tierra) concerning the *Preliminary Geochemical Evaluation Lower Passaic River Restoration Project* (Preliminary Geochemical Evaluation) (Malcolm Pirnie, 2005) and the *Draft Geochemical Evaluation (Step 2) Lower Passaic River Restoration Project* (Step 2 Geochemical Evaluation) (Malcolm Pirnie, 2006). The comments are presented in three categories:

- Overarching comments pertinent to both the Preliminary Geochemical Evaluation and the Step 2 Geochemical Evaluation;
- Comments (both general and specific) pertaining to the Preliminary Geochemical Evaluation; and
- Comments (both general and specific) pertaining to the Step 2 Geochemical Evaluation.

Please note that the Preliminary Geochemical Evaluation is referred to as *Geochemical Evaluation Step 1* on the [www.ourPassaic.org](http://www.ourPassaic.org) website. There is no title-page associated with the document as it appears on the website, but the footer on each page identifies it as the Preliminary Geochemical Evaluation. Therefore, for clarity, we refer to this document as the Preliminary Geochemical Evaluation within these comments. The term "Geochemical Evaluations" in these comments refers collectively to the Preliminary Geochemical Evaluation and the Step 2 Geochemical Evaluation. Additionally, the Lower Passaic River (LPR) is defined as the lower 17 miles from Newark Bay to the Dundee Dam. When the Passaic River is referenced, it refers to any area within the Passaic River (above or below the Dundee Dam).

## **Overarching Comments to Geochemical Evaluations**

1. **The overall purpose, intent, and use of the information and analyses presented in the Lower Passaic River Restoration Project (LPRRP) Geochemical Evaluations (Preliminary and Step 2) are not clearly stated.**  
Section 1, *Introduction and Summary* of the Step 2 Geochemical Evaluation states that "*This geochemical evaluation presented in this document represents an important step in the on-going remedial investigation and feasibility study for the Lower Passaic River.*" In Section 6, *Conclusions and Observations*, the Step 2 Geochemical Evaluation states that "*These conclusions and observations should*



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*"Sediment deposition rates in Lower Passaic River (RM 0.9 to 7) have a high degree of spatial variability, varying from about -6 inch/year of erosion to about +8 inch/year of deposition over short distances."* Bathymetric data show evidence of processes in the LPR that are consistent with expected geomorphology for meandering river/estuarine channels. Point-bar formations with thick accumulated sediment deposits occur along the inside bank at river bends, while deeper areas with limited sediment deposition occur at the outer bends (where the flow energy and turbulence are greater). Erickson et al. (2007) describes these geomorphic features (i.e., point-bars, river bends) within the LPR and discusses consistency of sediment deposition rates within the geomorphic features of the LPR. The spatial variability can be better understood by evaluating the data in the context of river geomorphology. Additionally, as discussed in Section 4.3 of the Step 2 Geochemical Evaluation, *Downcore Profiles and Contaminant History*, contaminant profiles have been preserved at depths corresponding to the peak historical loadings in depositional areas, further supporting the need for assessment of sedimentation in a geomorphic feature context. The Geochemical Evaluations should be re-visited to reassess the data based on channel geomorphology.

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5. **The conclusions reached and the CSM established by the authors do not consider existing information maintained by USEPA regarding contaminant sources.** USEPA has a vast collection of documentation on many sources of many contaminants to the Lower Passaic River Study Area (LPRSA) and the Newark Bay Study Area (NBSA). Some sources are purely historical, some are ongoing today. The information and documentation has been compiled from publicly accessible resources through research conducted by Tierra and others, including information obtained through Federal Freedom of Information Act

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Numerous documents regarding contaminant sources to the LPRSA and NBSA have been submitted to and evaluated by USEPA, and made part of USEPA's ongoing enforcement strategy regarding Potentially Responsible Parties (PRPs). These include data regarding historic and ongoing sources of various hazardous substances, including, but not limited to, dioxins (and specifically, 2,3,7,8-TCDD), polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), and mercury. USEPA has utilized this information to notify PRPs regarding their liability for conditions in the LPRSA and/or NBSA through the issuance of General Notice Letters. Despite the existence of this data, the mass balance attempted in the Malcolm Pirnie CSM completely ignores these sources of hazardous substances while, at the same time, these hazardous substances are the focus of the mass balance presented. Additionally, and incredibly, numerous statements are made in the body of the Geochemical Evaluations regarding the lack of known, additional sources for these specific hazardous substances.

- 6. In presenting the data, data analyses, previous research, and the authors' conclusions, the report contains a number of flaws in logic and inductive reasoning, resulting in conclusions not following from their purported premises.** Some of these flaws reflect common fallacies, such as the following, described in philosophical literature:

- a. Circular Reasoning:** An argument in which a premise presupposes the conclusion in some way.

Example of Circular Reasoning in Malcolm Pirnie's report:

*"The adjustment made to the solids load from the LPR was essential to balance 2,3,7,8-TCDD and TCDD simultaneously. No other source to Newark Bay had the correct characteristics (e.g., 2,3,7,8-TCDD concentrations, 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio, and solids) to complete the mass balance" (page 4-25 Step 2 Geochemical Evaluation). This mass balance result was used in the report to prove that the LPR is the primary source of 2,3,7,8-TCDD.*

Problem: The analysis does not work unless the LPR is presumed, a

*priori*, to be the primary source of 2,3,7,8-TCDD; but that very notion is exactly what the report is purporting to prove. (i.e., The notion, in order to be "proven," must first be presumed.)

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- b. **Fallacy of Exclusion:** An argument in which evidence that would change the outcome of an inductive argument is excluded from consideration.

Example of the Fallacy of Exclusion in Malcolm Pirnie's report:

*"As a first attempt, the 2,3,7,8-TCDD came fairly close to the target value for Newark Bay sediments but the  $\Sigma$ TCDD concentration was too high, yielding a low ratio for the Newark Bay sediments" (p. 4-25, Step 2 Geochemical Evaluation). Therefore, loads from the LPR were increased and loads from Arthur Kill and Kill van Kull were reduced.*

Problem: Alternative approaches were neither contemplated nor discussed in the report. To address this problem, sources that contribute disproportionately to  $\Sigma$ TCDD (in order: Passaic River, Arthur Kill, Hackensack) and sources that are relatively low in 2,3,7,8-TCDD contribution (in order: Kill van Kull, Arthur Kill, Hackensack River) could be reduced. For example, reductions in Arthur Kill and Hackensack would have had a greater impact on estimated  $\Sigma$ TCDD contributions than on 2,3,7,8-TCDD. Indeed, adjusting non-matching ratios from those sources may correct the problem of incorrect concentrations, provided that the total volume loads from any of those sources would be enough to balance the concentration estimates.

- c. **Undistributed Middle:** An argument in which two separate categories are said to be connected, because they share a common property.

Example of Undistributed Middle in Malcolm Pirnie's report:

The authors propose a model in which the 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio can implicate a source on the basis of similar characteristics. For example, *"The diagnostic ratio of 2,3,7,8-TCDD/ $\Sigma$ TCDD of 0.7 to 0.8 can be used to trace Lower Passaic River PCDD throughout the Newark Bay complex ..."* (p.4-9, Step 2 Geochemical Evaluation). If portions of Newark Bay and the LPR have similar 2,3,7,8-TCDD/ $\Sigma$ TCDD ratios the report concludes that there is a common source of 2,3,7,8-TCDD for both areas, and there is a

unique causal link between the 2,3,7,8-TCDD in the LPR and the 2,3,7,8-TCDD in Newark Bay.

Problem: The 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio could result from a combination of any of several different sources and causes, and those possibilities were not considered.

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These issues are described in more detail below.

**Concerns relating to sources of error in mass-balance calculations in general:**

Geochemical estimation is subject to uncertainty from a number of factors, including analytic uncertainty, dating uncertainty, and measurement uncertainty due to independent estimates of concentrations based upon sparse measurements. Evidence of the range of measurement errors includes the derivation of logically impossible ratios (i.e.,  $\geq 1$ ) of 2,3,7,8-TCDD/ $\Sigma$ TCDD concentrations (see Figure 4.6).

**Concerns relating to arguments that failed to consider a full range of options in calculating TCDD Mass Balance:**

The estimated ratio of 2,3,7,8-TCDD/ $\Sigma$ TCDD for Newark Bay was too low, given the measured concentrations and estimated solid loads into Newark Bay. Given that the ratio was too low, either the denominator ( $\Sigma$ TCDD) is too high, or the numerator (2,3,7,8-TCDD) is too low, or both. Therefore, there are three possibilities for correcting the ratio:

- Option 1: Decrease the denominator by reducing the amount of solid loads from any source (e.g., Hackensack River, Passaic River, Arthur Kill, Kill van Kull);
- Option 2: Increase the numerator by increasing the transport of 2,3,7,8-TCDD into the Bay from any source;
- Option 3: Simultaneously and disproportionately change the denominator and the numerator.

According to Malcolm Pirnie, an analysis of available data suggested that the denominator, or  $\Sigma$ TCDD estimate, is too high: *"As a first attempt, the 2,3,7,8-TCDD came fairly close to the target value for Newark Bay sediments but the*

*ΣTCDD concentration was too high, yielding a low ratio for the Newark Bay sediments" (p. 4-25, Step 2 Geochemical Evaluation).*

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Nevertheless, Malcolm Pirnie chose Option 3 -- increasing the loads from sources that are high in 2,3,7,8-TCDD but relatively low in solids load, and also decreasing the load of solids coming from Arthur Kill and Kill van Kull. However, as indicated above, this was not the only option for closing the mass balance. No logical, theoretical, or empirical argument is given regarding whether or why Option 3, rather Option 1 or 2, may be the best option for achieving a more valid ΣTCDD estimate.

Alternatively, to address this problem, sources that contribute disproportionately to ΣTCDD (in order, Passaic River, Arthur Kill, Hackensack) and that contribute relatively little 2,3,7,8-TCDD (in order: Kill van Kull, Arthur Kill, Hackensack River) could be reduced. For example, reductions in Arthur Kill and Hackensack would have had a greater impact on estimated ΣTCDD contributions than on 2,3,7,8-TCDD. Indeed, adjusting contributions from those sources could correct the problem of incorrect concentrations, provided that the total volume loads from any of those sources would be enough to balance the concentration estimates. There is no evidence that such an analysis was conducted, and this possibility was not discussed in the report.

**Concerns relating to arguments regarding the calculation of sources of 2,3,7,8-TCDD and ΣTCDD mass balance:**

Regarding the 2,3,7,8-TCDD/ΣTCDD ratios being too low, there are a number of sources from which to choose, and it is possible to increase multiple sources of 2,3,7,8-TCDD simultaneously to increase the numerator. Malcolm Pirnie chose to increase only one, higher 2,3,7,8-TCDD source—namely, the Passaic River—while ignoring other possible sources. In doing so, Malcolm Pirnie assumed that the Passaic River was a source of relatively high concentrations of 2,3,7,8-TCDD, but that question is one being investigated in the first place (see p. 1-1, Step 2 Geochemical Evaluation). Malcolm Pirnie viewed its assumption as essential to the completion of a coherent mass balance analysis: *"The adjustment made to the solids load from the LPR was essential to balance 2,3,7,8-TCDD and ΣTCDD simultaneously"* (p. 4-25, Step 2 Geochemical Evaluation).

The possibility exists that the error in the estimate of TCDD is attributable to measurement error or possible unidentified sources (see the discussion of

mercury sources on p. 4-27, Step 2 Geochemical Evaluation). The artificial increase in the Passaic River load, to correct a potential measurement error, increases the chance that the 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio in the Newark Bay is an artifact of measurement error (e.g., as demonstrated by the logically impossible 2,3,7,8-TCDD/ $\Sigma$ TCDD ratios  $\geq 1$ ) and the subsequent modeling adjustments. Given that the contribution of the LPR is at issue, analyses should strive to minimize the chance of artifact associated with that body.

**Concerns relating to arguments regarding the calculation of mercury mass balance:**

Malcolm Pirnie found that its estimate contained a significant amount of mercury that could not be explained by the identified sources and estimated volumes. It is interesting to note that the greatest contribution of both Arthur Kill and Kill van Kull to the Newark Bay chemical mass balance is mercury. In decreasing the denominator of the ratio by reducing solids from Arthur Kill and Kill van Kull, Malcolm Pirnie increased the risk that some chemical mass balances due to the presence of Kill van Kull or Arthur Kill solids would be unexplained or under-explained. Given the massive volume of solids from both of those sources, even a small-percentage reduction could be problematic for an analysis of the mercury concentration and volume.

On the other hand, artificially increasing the solids load from the Passaic River to arrive at sufficient  $\Sigma$ TCDD concentration in Newark Bay, induces an increase in the estimated loads of mercury without being able to account plausibly for how that mercury arrived in the Bay (it being highly unlikely that the Passaic River could be the source of the additional mercury, because there are not enough solids coming out of the mouth of the Passaic to transport the putative load of mercury). Also, the greatest sources of mercury are Arthur Kill and Kill van Kull. Therefore, to account for mercury concentration and volume in Newark Bay, there must be a large source of solids other than the Passaic River. Note that such alternative source(s) also could be adjusted to achieve adequate 2,3,7,8-TCDD or  $\Sigma$ TCDD concentrations, because its properties are undetermined. Moreover, the size of such alternative source(s) of solids could be sufficient to exert a significant impact on the  $\Sigma$ TCDD concentration and the 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio in the Newark Bay. In addition, the location(s) of the source(s) could significantly affect whether there is evidence of a signature Passaic River concentration and estimates of what that signature concentration might be.

**Concerns relating to the manner of application of the mass balance**



**bootstrapping technique:**

In the introduction to section 4.6, Step 2 Geochemical Evaluation, Malcolm Pirnie indicates that it is adopting a methodology in which it is important that masses of contaminants are simultaneously balanced. The first part of section 4.6, Step 2 Geochemical Evaluation, is concerned with the challenge of balancing 2,3,7,8-TCDD and  $\Sigma$ TCDD simultaneously. Malcolm Pirnie iterates through estimated loads and concentrations of 2,3,7,8-TCDD and  $\Sigma$ TCDD until a satisfactory balance is achieved. The total quantity of contaminants in the Newark Bay and its environs included mercury, and the latter part of the report is concerned with that chemical. However, no effort is made in the report to iteratively combine the two mass balances, TCDDs and mercury, into a single consistent analysis of the total quantity of materials in the Bay sediments.

This is problematic, as any solution arrived at in the course of closing the mercury mass balance may itself introduce solids into the calculation that could change the quantities and estimated concentrations of 2,3,7,8-TCDD and  $\Sigma$ TCDD. Indeed, Malcolm Pirnie should have recalculated the 2,3,7,8-TCDD and  $\Sigma$ TCDD mass balance analysis under a bootstrapping approach, to include the extra "unknown" mercury source uncovered in the mercury analysis, unless it is assumed or argued that there is a source contributing mercury but not other chemicals.

**Preliminary Geochemical Evaluation, August 2005****General Comments:****1. Discrepancies in the data that have been resolved need to be addressed.**

Malcolm Pirnie noted that a comparison of the sources of data used in this assessment (Newark Bay and PREmis databases) contained several discrepancies that were not resolved prior to completing the Preliminary Geochemical Evaluation. Based on a review of the core profiles, it appears that one of the discrepancies was a result of an incorrect assignment of core IDs in the PREmis database (e.g., the core IDs are mislabeled on the profiles plots in the appendices). The LPRSA Cooperating Parties Group (CPG) notified the USEPA of this error in a memorandum dated September 19, 2005. On the [www.ourPassaic.org](http://www.ourPassaic.org) website, the USEPA acknowledged the discrepancy in the database and reissued PREmis on November 18, 2005. However, it does not appear that the Preliminary Geochemical Evaluation was reissued. The Preliminary



Geochemical Evaluation should be reissued with text explaining the reason for the re-issuance and appropriate modifications identified.

Preliminary Geochemical Evaluation (August 2005) and Step 2 Geochemical Evaluation (March 2006)

2. **Exclusion of data used in the analysis needs to be quantified.** In several instances throughout the Preliminary Geochemical Evaluation, the analyst excluded cores from the associated analyses based on a specified screening process (e.g., sediment not analyzed for full suite of isomers, rejected data). The number and/or percentage of affected cores should be provided in the report to document the magnitude of the impact of this screening process.
3. **An explanation of how the sedimentation rates were calculated is needed.** The text states *"Location-specific sedimentation rates (inches/year) were calculated for each cesium profile (whenever possible)....A second location-specific sedimentation rate was calculated with the Po[sic]-210 profile."* The text should specify how the sedimentation rates were calculated from the Cesium-137 (Cs-137) and Lead-210 (Pb-210) data.

**Specific Comments:**

1. **Page 2, Second Bullet.** Upon which "select contaminants" are the authors basing this conclusion? Why were these contaminants selected versus others? If tidal mixing is sufficient to homogenize the contaminants, as the authors postulate, why must there be a small number of sources and why must they be located proximate to each other? The reasoning for such statements should be explained within the Preliminary Geochemical Evaluation.
2. **Page 2, Third Bullet.** This statement does not account for the potential for contaminant sources located above Dundee Dam to be impacting the LPR.
3. **Page 2, Fifth Bullet.** The text suggests transport of contaminants out of the Passaic River, through Newark Bay, and into the Hudson-Raritan Estuary; however, no supporting references and contaminant fate and transport analysis are provided. Pertinent citations and analysis should be provided. Also, the authors do not acknowledge the known transport of sediment **from** Newark Bay **into** the LPR.
4. **Page 3.** The discussion of databases on this page does not reflect the known errors resulting when Malcolm Pirnie imported the Tierra data into the PREmis database. In fact, the third paragraph on this page acknowledges the discrepancy

between the Malcolm Pirnie-maintained PREmis database and the database submitted by Tierra to the USEPA as part of the Newark Bay remedial investigation. The authors conclude with *"Reconciliation of the databases was beyond the scope of this effort. As a result, Malcolm Pirnie relied exclusively on the PREmis database to avoid duplicates."* This resulted in preparing the Preliminary Geochemical Evaluation based on erroneous data. The Preliminary Geochemical Evaluation should be reissued based on a reanalysis of the corrected database.

5. **Page 4, First Three Paragraphs.** There are many stated simplifications and generalizations in these paragraphs that may have an impact on the interpretations developed. It is beyond the scope of this comment document to attempt to quantify the impact of these simplifying statements, but these statements call into question the resulting CSM and other conclusions derived from this work.
6. **Page 5, Second Paragraph.** The metadata that the authors desire is located in the Work Plan and Quality Assurance Project Plan that were prepared for the 1995 sampling program. Post-sampling metadata were not developed because the USEPA instructed Tierra not to proceed with developing the remedial investigation report. Further, this paragraph is confusing in that the authors state that *"...no metadata was [sic] available to define which analytes were included in the summation of total tetra-CDD"* and *"A separate summation of tetra-CDD was not possible..."* Yet, the authors calculate a 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio without explaining the impact of the previously noted issues.
7. **Page 5, Third Paragraph.** The authors inconsistently describe the samples used in different analyses (see General Comment 2 to the Preliminary Geochemical Evaluation). The text in the third full paragraph states *"Sediment samples that were not analyzed for all 17 compounds were excluded from the analysis to avoid bias-low summations."* Later in that same paragraph, the authors acknowledge exclusion of 52 non-detect samples on their graphs. To allow for replication of the analyses, each analysis should accurately specify how many samples were excluded.
8. **Page 6, First Paragraph.** The methods presented for performing the principal components analysis (PCA) should be clarified. For example, the authors do not present the process for normalizing the data, nor do they list the samples that were confirmed as outliers based on the "Jackknife Distance" test. A clear understanding of the details of these and other components is necessary to be able to follow and

reproduce the computations presented within the Preliminary Geochemical Evaluation.

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9. **Page 6, Last Paragraph.** The text implies that the bottom of the core segments did not properly align with the Cs-137 segments due to collection of two cores at a given location (one core for chemical and one core for radiochemical). Two errors are propagated with this text. First, the radiochemical samples were collected from the *same* core as the samples for chemical analysis (this is clearly documented in the Remedial Investigation Work Plan (USEPA, 1995). Second, the segmentation scheme was different for the cores due to different sampling objectives: radiochemical samples were collected from thin sections to calculate the average sedimentation rate; chemical samples were collected from the same core, but with broader segmentation to assess concentration trends with depth. Accordingly, the erroneous text should be corrected to clarify that the nonalignment of the chemical sample segments and the radiochemical sample segments was intentional and in accord with the method's design to address two different objectives.
10. **Page 9, First Paragraph.** The text states that the uncertainty was assumed to be 6 inches. Herzog and Bradshaw (2005) present a method for calculating uncertainty and test this method using the same bathymetric survey data from the Passaic River as was used in the Geochemical Evaluations. Their computed uncertainty for the Passaic River ranged from  $\pm 0.12$  to 0.49 meters (0.39 to 1.6 ft) depending on the years of the surveys compared. The Herzog and Bradshaw procedure should be used, as it provides a more accurate and defensible method for assessing bathymetric comparison uncertainty. All bathymetric comparisons should be systematically evaluated with this method, and results outside of the selected confidence interval clearly indicated.
11. **Page 10, Second Paragraph.** The text refers to Table 3; however, this table is not provided with the Preliminary Geochemical Evaluation.
12. **Page 11, First Paragraph.** The parenthetical statement "*(Note that other CSOs are present throughout the Passaic River; however, those CSOs do not appear to be important sources, based on the absence of change in the local contaminant/Cs-137 ratios.)*" is unsubstantiated. The authors need to demonstrate that sediment samples were collected sufficiently close to each of the CSOs in the Passaic River, that the contaminant/Cs-137 ratios could be calculated for each of these samples, and then demonstrate quantitatively that there was an "absence of change" after defining what is meant by the term "absence."

- 13. Page 11, Bottom Paragraph.** In this paragraph, the authors discuss DDT and 2,3,7,8-TCDD data from the 1995 remedial investigation/feasibility study (RI/FS) cores in context of a contaminant chronology theory originally presented by Bopp et al. (1991). Bopp noted that in one Newark Bay dated core, the peak concentration of p,p'-dichlorodiphenyl dichloroethane (p,p'-DDD) (a degradation product of DDT) was observed in pre-1954 sediments and the peak concentration of 2,3,7,8-TCDD was observed in highest concentrations in mid-1960s sediments. Bopp noted that these dates were consistent with dates of peak DDT and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) production at the 80 Lister Avenue Site, located along the LPR. Thus, Bopp concluded that both dioxin and DDT data in Newark Bay were consistent with a predominant 80 Lister Avenue source.

The authors acknowledge that there are several core locations in the Passaic River that **do not** show the contaminant chronology predicted by Bopp et al. (1991). However, by speculating that *"some profiles do not appear consistent with the Bopp et al., (1991) model because of discontinuous sediment deposition"* and, alternatively, that such inconsistencies might be due to *"compositing large core segments"* this paragraph of the Preliminary Geochemical Evaluation still suggests that the Bopp DDT chemical tracer argument might be applicable.

As discussed in more detail later in these comments (see Specific Comment 30 in the Step 2 Geochemical Evaluation section of these comments), a careful examination of the data does not support such speculation. In the Step 2 Geochemical Evaluation, the authors identified 12 cores with reliable sediment chronologies and internally consistent chemical profiles. Of these 12 cores, fewer than half show the contaminant chronology predicted by Bopp et al. (1991). The DDT and 2,3,7,8-TCDD data from the 1995 RI/FS clearly illustrate that Bopp's predicted DDT/TCDD chronology is not consistently observed, even in LPR cores near the 80 Lister Avenue Site. This clearly suggests that there have been multiple sources of one or both of these analytes -- a suggestion that is consistent with the body of evidence maintained by USEPA regarding sources of these hazardous substances.

- 14. Page 15, First Paragraph.** The authors state that *"Spatially, the sedimentation rates appear heterogeneous, ranging from areas of scour to areas of high sedimentation rates (greater than 5 inches/year), which suggests episodic deposition, erosion, and dredging events throughout the river."* and *"...the data suggest a dynamic sediment transport system such that areas of scour and deposition are not strictly dictated by the curvature of the channel. For example,*

*areas of scour are located both on the straight sections as well as the meanders."* The authors appear to be suggesting from these statements that the LPR is a net-erosional environment. This is not the case. It is evident from Figure 22 that there are both depositional and non-depositional areas within the LPR; however, distinct regions of similar sedimentation rates exist, and can be explained by classical channel morphology (see Overarching Comment 3, above). On the basis of channel morphology, the sedimentation results reflect expected patterns. Non-depositional areas are located primarily on the outside of river bends, while the most depositional areas are typically found along point bars on the inside of river bends (as evidenced by the thalweg meander). In the LPR, there is both a large amount of deposition in the former navigation channel, and localized scour areas related to bridge structures (flow constriction through abutments or piers). Overall, these results show the highly depositional nature of the Passaic River estuary and are consistent with published descriptions of long-term geomorphology for Atlantic Coastal Plain estuaries.

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- 15. Page 16. Second and Third Paragraphs.** The statement "...these contaminated sediments would then be mixed and transported throughout the Hudson-Raritan Estuary" is not substantiated. The authors fail to discuss the transport of sediments from Newark Bay into the LPR. Suszkowski (1978) suggested that sediments are brought back to the LPR along with sediments from downstream sources by the net upstream flow of bottom waters.

The second paragraph also calls on the work of Chaky (2003) in support of the authors' statement that tidal mixing would cause contaminated sediments from the Passaic River to be mixed and transported throughout the Hudson-Raritan Estuary. For the reason's discussed below, the Authors' reliance upon Chaky's work introduces fatal uncertainty into their hypotheses and findings based thereon.

**Flaws in Chaky's work:**

Chaky's theory is that the LPR is the primary source of 2,3,7,8-TCDD in sediments as far away as Hastings, New York (more than 30 miles from Newark Bay). That argument was based on use of the 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio, which in turn is based on a seriously flawed assumption. Chaky argued that a high ratio of 2,3,7,8-TCDD to  $\Sigma$ TCDD ("TCDD ratio") in the sediments of upper Newark Bay and the Passaic River is diagnostic of 2,4,5-T production. Chaky argued that this ratio was also particularly useful due to similar physical properties of both 2,3,7,8-

TCDD and  $\Sigma$ TCDD. That is, the chemical properties of both analytes used in a ratio are similar; thus, the ratio should be minimally affected by alteration processes. In further support of this argument, Chaky pointed to a 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio of 0.71 in sediments of upper Newark Bay, as compared to much lower ratios for three other presumed source areas identified as: (1) Central Park (Manhattan, NY) Sediments (0.06 – primarily atmospheric sources), (2) Newtown Creek (Queens, NY) Sediments (0.04 – primarily a sewage source), and (3) upstream Hudson River Sediments (<0.05).

Considering the high ratios in Newark Bay and low ratios in Central Park, Newtown Creek, and upstream Hudson River, Chaky then made a leap in logic, concluding that any sample in Newark Bay, New York Harbor, or the Hudson River with a TCDD ratio >0.06 constitutes evidence of an LPR dioxin source. His rationale for this argument was based upon two unstated assumptions:

- Within his data set (67 samples), there are four areas that represent pure source “end-members”: (1) upstream Hudson River (industrial source not identified), (2) Newtown Creek (primary source: sewage), (3) Central Park (primary source: atmospheric), and (4) the “Western Harbor” or Passaic River source (primary source: 2,4,5-T production).
- Chaky assumes that there are no other polychlorinated dibenzo-*p*-dioxin (PCDD)/polychlorinated dibenzofuran (PCDF) sources in the region, or at least that there are no other sources with a TCDD ratio > 0.06.

The data presented by Chaky are insufficient to support these assumptions. Curiously, one needs to look no further than Chaky's thesis to find two examples that successfully challenge these key assumptions. Chaky's study included Core JB13 from Jamaica Bay, NY. Jamaica Bay is a tidal marsh near JFK Airport that connects to the Atlantic Ocean through an inlet. There is no direct link to New York Harbor or Newark Bay, except via the open ocean. Dioxin data were collected from only two samples in Core JB13. The deeper sample (32 cm to 36 cm) from this core yielded a TCDD ratio of 0.28, which is much higher than 0.06. In Jamaica Bay, Chaky (2003) discounted the possibility of an LPR source because of geographic constraints, and instead, considered the possibility that Silvex

(2,4,5-T) might have been used there as an herbicide. He did not offer a hypothesis on what circumstances might preclude the use of such a product elsewhere in the region.

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Another exception to Chaky's assumption is seen in one sample collected far upstream of Hastings on the Hudson River. In his inter-laboratory data comparison, Chaky included PCDD/PCDF analyses from two different labs: Axys and Severn-Trent. Chaky evaluated potential inter-laboratory bias by looking at PCDD/PCDF data in blind duplicates run by both labs. One of the blind duplicates was from the upper Hudson River, just downstream of Federal Dam. The Axys duplicate yielded a TCDD ratio of 0.14. The Severn-Trent blind duplicate yielded a TCDD ratio of 0.28. Chaky reported that this sample had the poorest agreement among the seven blind duplicates analyzed, but he omitted the fact that both analyses yielded ratios greater than twice that of the Central Park and Newtown Creek values. Unlike the Jamaica Bay data, Chaky declined to speculate on the source of TCDD in this sample.

In summary, the data presented by Chaky are not only insufficient to support his key assumptions, but even go so far as to contradict his assumptions. Certainly, the TCDD ratio has not yet undergone sufficient scrutiny to be used as a diagnostic fingerprinting tool.

- 16. Page 16, Last Paragraph.** Once again, this paragraph alludes to the potential utility of total DDT as a non-dioxin chemical tracer and/or proxy analyte for predicting areas of high concentrations of 2,3,7,8-TCDD. This strategy was addressed in Specific Comment 13, above, and will be addressed again, in greater detail, later in these comments (see Specific Comment 30 to the Step 2 Geochemical Evaluation section, below). In short, the DDT and 2,3,7,8-TCDD data from the 1995 RI/FS clearly illustrate that Bopp's predicted DDT/TCDD chronology is not consistently observed in Passaic River sediments. This fact, together with the body of evidence maintained by USEPA regarding other sources, clearly suggests multiple sources of one or both of these analytes.
- 17. Page 17, Bullet 3.** As described in Specific Comment 16, immediately above, the significance of any relationship between loading of DDT and 2,3,7,8-TCDD to the Passaic River, and any relevance of any such relationship to other areas of the Newark Bay Estuary and/or the Hudson-Raritan Estuary, have not been proven.



Therefore the statement contained in Bullet 3 is speculative and should be removed.

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- 18. Page 17, Bullet 6.** Given the importance and usefulness of the historical data, why was this analysis conducted without considering polychlorinated biphenyls (PCBs) and heavy metals? A Conceptual Site Model (CSM) of the LPR cannot be developed without considering other constituents (e.g. PCBs and heavy metals). Understanding the distribution of these other constituents will assist in the interpretation of the sedimentary record of the LPR as well as the influence of historical and ongoing source loadings..

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**General Comments:**

- 1. Uncertainty in the geochemical evaluation should be quantified.** The Step 2 Geochemical Evaluation presents several empirically based calculations using input values that are not well constrained. These uncertainties are acknowledged by the authors; however, sensitivities of the calculations to variations and ranges of the inputs are not quantified. To measure the utility of the calculations in the decision-making process and the potential importance of these analyses to the CSM, it is necessary to document the effects of uncertainties on the calculations and analyses presented. A sensitivity analysis (based on bounds of the input values) of the calculations should be performed and the uncertainty of the calculations quantified. Specific comments regarding sensitivity to bathymetric comparisons and chemical mass balances are provided in the Specific Comments section. In addition, all calculations and sensitivity analyses should be documented to allow for review.
- 2. Hydrodynamic record should be included in the bathymetry assessment.** The bathymetric comparison analysis assigns an uncertainty based upon professional judgment, and omitting an assessment of the hydrodynamic record which, if included, could help explain patterns of erosion and deposition. Hydrodynamic events, comprising both flood events and large fluctuations in water level, have the potential to impart high episodic flows in the LPR, potentially causing erosion, rapid deposition, and mixing of the sediment bed. Additionally, flood events typically deliver major sediment loads. The authors present frequent qualitative remarks (e.g., "...suggest erosion occurred...") without substantiating the possibility of such an event by a comparison to the hydrodynamic record.



3. **The polycyclic aromatic hydrocarbon (PAH) source evaluation was incorrectly applied.** The forensic PAH evaluation seems to characterize the sediments as being an almost homogeneous mix of different sources of PAHs from petrogenic and combustion sources. Evaluating the PAH dataset as a whole can result in this type of conclusion, and can be misleading in identifying important contributing sources of PAHs in the Passaic River. The PAH data should be evaluated first to identify similar PAH and total petroleum hydrocarbon (TPH) characteristics among samples. Samples of similar characteristics should then be evaluated according to their location(s) on the river. Knowing the present-day and historical uses of the river, the potential sources of PAHs could be determined. It would be expected (considering the history of the Passaic River) that distinct sources of PAHs would be identified and help to explain the distribution of PAHs in the river. The generalities from evaluating the dataset as a whole do not help to explain the different types of PAH sources in Passaic River sediments or in areas of the Passaic River that have experienced inputs from different sources of PAHs to the river system. As noted in Specific Comments 40-43, below, there are serious flaws in the authors' use of the diagnostic PAH ratios and interpretative techniques offered in the literature. Section 4.5.3 of the report, involving PAH forensic evaluation, and the associated conclusions, should be reconsidered in light of these comments.

4. **There are deficiencies in the TCDD source evaluation.** The Step 2 Geochemical Evaluation focuses upon only one 2,3,7,8 substituted PCDD/PCDF congener: 2,3,7,8-TCDD. It is well established in the literature that significant environmental sources contribute dioxins and furans to the environment through PCDD/PCDF congeners **other than** 2,3,7,8-TCDD. For example, combustion sources and pentachlorophenol are both considered major contributors to the global PCDD/PCDF budget (Baker and Hites, 2000). However, while 2,3,7,8-TCDD is present in such sources, it is but one of seventeen 2,3,7,8-substituted congeners that are characteristic of those sources (Cleverly et al., 1997; 2001).

Even in Newark Bay and the Passaic River, the presence of other sources cannot be in dispute. Bopp et al. (1991) included analysis for three PCDD/PCDF congeners (2,3,7,8-TCDD, 2,3,7,8-tetrachlorodibenzofuran [2,3,7,8-TCDF], and OCDD). With respect to OCDD, Bopp et al. (1991) concluded: *"the rather poor correlation between OCDD and 2,3,7,8-TCDD levels in our samples ( $R^2 = 0.36$ , Figure 3) indicates that there is significant regional source of OCDD, a source that is depleted in 2,3,7,8-TCDD relative to the local industrial source. Combustion and the use of pentachlorophenol, a common wood preservative, are the most likely*

*candidates for this regional PCDD source.*" This conclusion is consistent with the body of evidence maintained by USEPA for the Site, which indicates the existence of multiple sources.

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In contrast, Bopp's comparison of 2,3,7,8-TCDD and 2,3,7,8-TCDF yielded a high  $R^2$  that led him to conclude one common source for both of these congeners (Bopp et al., 1991). However, there was a major problem with that analysis -- Bopp's data included only one core from the LPR. Bopp's single-source hypothesis cannot be sustained for the following reasons:

- The core was collected in the Passaic River immediately adjacent to the 80 Lister Avenue Site and accounted for only five of the 29 samples in Bopp's  $R^2$  calculation. The two highest concentration samples from that core highly leveraged the seemingly impressive  $R^2$  cited by Bopp. If one removes those samples from the calculation, the  $R^2$  for the remaining samples drops to a much less compelling 0.58.
- Chaky (2003) revisited Bopp's single-source argument for 2,3,7,8-TCDF and 2,3,7,8-TCDD, and concluded the following: *"Although Bopp et al., (1991) suggested that the 2,3,7,8-TCDF distribution in Newark Bay sediments was also a tracer of 80 Lister Avenue influence, no such relationship is evident from the analysis for this thesis.*
- Chaky's (2003) conclusion, stated above, is confirmed by analysis of available data for these congeners in the Tierra 1995 RI/FS database. This data set includes congener-specific PCDD/PCDF analyses for 537 samples collected from 93 core locations. If a single-source hypothesis for both dioxins and furans can be salvaged, then certainly we should see a high  $R^2$  between 2,3,7,8-TCDD and 2,3,7,8-TCDF in this data set. But the  $R^2$  between 2,3,7,8-TCDD and 2,3,7,8-TCDF in the 1995 RI subset of the database is 0.12. If one looks only at surface sediment samples from the 1995 RI/FS data set, there results, yet again, a low  $R^2$  of 0.23.

Clearly there is evidence of multiple sources of furans and dioxins in the Passaic River, and the authors' focus on only one congener (2,3,7,8-TCDD) effectively discounts and disregards such multiple sources. Again, this evidence is also consistent with the body of evidence maintained by USEPA.

5. **The reported chemical mass balance results both misrepresent and carry undue importance toward advancing concepts relating to site conditions (i.e., contaminant mass).** Uncertainty associated with chemical mass balance computations is not accounted for in the authors' final conclusions. The highly uncertain nature of the calculations used in the chemical mass balance calculations is not fully presented or acknowledged by the authors. Furthermore, the chemical mass balance calculations are made using data with unconstrained uncertainty and inputs, thus compounding the uncertainty in the final computations. For example, the authors state that the volume of solids has uncertainties associated with its calculation; however, such uncertainties are not quantified. These volumes are subsequently used with the average chemical concentrations (which contain no upper and lower bounds) to solve the chemical mass balances.

Although there are several areas where uncertainty can be introduced, the authors computed annual mass loadings of mercury and 2,3,7,8-TCDD (see fourth bullet on page 4-19) without stating the uncertainties associated with these mass loading results. In general, it must be recognized that additional data are required to provide any reasonable assurance of the validity of conclusions resulting from these analyses. To accept anything less will lead to incorrect results and inappropriate decision making.

6. **The chemical mass balances are solved using inconsistent methods.** The authors use an *a priori* assumption of a single source of TCDD with a known diagnostic 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio of 0.71 to complete their mass balance calculations for 2,3,7,8-TCDD and  $\Sigma$ TCDD. The authors describe in great detail in section 3.3 their justification for calculating a revised solids volume for the solids load from the Passaic River to Newark Bay. When the ratio does not hold for the mass balance using the revised solids volume from Table 3-3, the authors propose a revised solids volume (almost 3 times that previously calculated) to account for the discrepancy. A more logical conclusion is that the assumption of a single source of TCDD is incorrect.

Neither the uncertainty associated with solids volume nor the average 2,3,7,8-TCDD calculations are considered in the mass balance computations (see General Comment 5 to the Step 2 Geochemical Evaluation). However, the authors conclude that *"Both the volume of solids deposited annually as well as the mass of solids load requirements for this chemical mass balance is [sic] considered to be well within the likely range of conditions."* This statement cannot be substantiated without providing the range of uncertainty.

When computing the mercury mass balance, the authors attribute the inability to solve the mass balance to an unidentified source in Newark Bay. The overall methods for solving the mass balances are inconsistent – adjusting solids for 2,3,7,8-TCDD, but adjusting sources for mercury – and do not follow a systematic process. The authors cannot reasonably conclude that the mass balance for 2,3,7,8-TCDD is complete (with an adjustment in the solids volume), yet the mercury mass balance is not complete given the same level of data used in each computation. In fact, documents maintained by USEPA and used in the ongoing PRP enforcement effort for the NBSA contain evidence regarding local sources of releases to the NBSA of both these hazardous substances – 2,3,7,8-TCDD and mercury.

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7. **Considerations for the extrapolation of contaminant mass.** When evaluating the number of cores with "concentration elevated or increasing at depth," the location of the cores within the Federal Navigation Channel must be considered. Based upon our understanding, the last dredging events in the LPR occurred in 1983 (Point-No-Point Reach) and 1949 (remaining reaches) respectively (Iannuzzi et al., 2002). The 1949 and 1983 dredging may have cut to "clean" sediments; therefore, the material that has accumulated since dredging could show a sharp gradient at the 1949/1983 horizons. Extrapolating the contaminant mass beyond the 1949/1983 dredge cut may largely overestimate the mass per unit area (MPA) calculations for cores within the Federal Navigation Channel limits.

**Specific Comments:**

1. **Page 1-1, First Paragraph.** This paragraph and the associated bulleted points which document why it was important to develop this analysis, point to a fundamental question with regard to the Step 2 Geochemical Evaluation: Why has this document been issued, and still in draft form, after so much work has been conducted in the LPR? One purpose of this document is to guide the CSM, which, in turn and along with the analyses contained in this document, should guide the development of work plans and the conduct of field investigations. This first page seems to reveal that the project has been conducted out of order and contrary both to established scientific protocols and guidance established by the USEPA for sediment investigations (USEPA, 2005).
2. **Pages 1-2 to 1-4, Bullets.** These pages, and specifically the bullets listed below, contain conclusions and observations that need to be re-evaluated and, in some

cases, corrected based upon the issues and points presented in these comments related to the accuracy of the authors' analyses.

- **Bullet 1.** This statement needs to be clarified and revised based on the issues presented in Specific Comment 24, below.
- **Bullet 2.** This statement needs to be revised based on the issues presented in Specific Comment 3, below.
- **Bullet 4.** This statement needs to be revised based on the issues presented in General Comment 3, above, and Specific Comment 31, below.
- **Bullet 11.** This statement needs to be revised based on the issues presented in Specific Comment 36, below.
- **Bullet 12.** This statement needs to be revised based on the issues presented in Specific Comment 36, below.
- **Bullet 13.** This statement needs to be revised based on the issues presented in General Comment 3, above, and Specific Comment 40, below.
- **Bullet 14.** This statement needs to be revised based on the issues presented in General Comment 5, above, and Specific Comment 48, below.
- **Bullet 15.** This statement needs to be revised based on the issues presented in General Comment 5, above, and Specific Comment 48, below.
- **Bullet 16.** This statement needs to be revised based on the issues presented in General Comment 5, above.
- **Bullet 17.** This statement needs to be revised based on the issues presented in General Comment 5, above, and Specific Comments 48 and 50, below.
- **Bullet 18.** This statement needs to be revised based on the issues presented in Specific Comment 51, below.
- **Bullet 19.** This statement needs to be revised based on the issues presented in Specific Comment 51, below.

- **Bullet 20.** This statement needs to be revised based on the issues presented in General Comment 7, above.
  - **Bullet 21.** This statement needs to be revised based on the issues presented in General Comment 7, above.
  - **Bullet 22.** This statement needs to be revised based on the issues presented in General Comment 7, above, and Specific Comment 55, below.
  - **Bullet 24.** This statement needs to be revised based on the issues presented in Specific Comment 56, below.
  - **Bullet 25.** This statement needs to be revised based on the issues presented in Specific Comments 53, 55, and 56, below.
3. **Page 2-2, Second Paragraph.** As part of the methodology for interpreting differences in bathymetry surveys, the sedimentation rates are averaged over 0.25-mile sections of the Passaic River. This method combines sedimentation rates associated with different geomorphologic features (see Overarching Comment 3) such as river bends and point bars and, therefore, masks trends of scouring and deposition that are evident on Figure 3-3. The average sedimentation rates should be computed for each geomorphic feature, providing empirical insight into the stability of the sediments in these regions.
  4. **Page 2-2, Third Paragraph.** The text states that comparing yearly surveys introduces additional uncertainty on the vertical control between the two surveys. The vertical control on each survey is a function of the pertinent survey's method and has nothing to do with post-survey manipulations. The process of comparing two bathymetric surveys does not alter the vertical control established at the time each survey was conducted. The authors should specifically state and quantify the additional uncertainty which they indicate is being introduced. As discussed previously, Herzog and Bradshaw (2005) present a method for computing uncertainty with regard to bathymetric comparisons.
  5. **Page 2-3, First Paragraph.** Has the uncertainty in sedimentation rates been quantified in cases where transects have not been co-located? How is it accounted for when comparing to surveys that have good agreement between survey transects? As discussed previously, Herzog and Bradshaw (2005) provide a methodology for determining uncertainty for bathymetric comparisons.

6. **Page 2-4, Second Paragraph.** This paragraph cites two documents that received numerous and significant comments from the LPRRP CPG and from Tierra, among (possibly) others. To our knowledge, these comments have not, to date, been addressed nor have the subject Pathways Analysis Reports been reissued with corrections. It is therefore inappropriate, and may potentially lead to erroneous conclusions, to base any part of this geochemical evaluation on such documents.
7. **Page 2-5, First and Second Paragraphs.** The text states that non-detect values were incorporated into a summation as a zero to "avoid biased totals." However, including a non-detect as a zero would create a low bias in the total. The authors should consider indicating simply that the non-detects were handled conservatively in calculations, as appropriate.
8. **Page 2-6, First Full Paragraph.** The criteria and rationale for selecting the 14 "interpretable" sampling locations (and therefore excluding 121 sampling locations) is not presented. Erickson et al. (2007) presents the geochronology for 121 cores collected from 1991 to 1995 based on radionuclides Cs-137 and Pb-210. Erickson et al. (2007) provides sedimentation rates and a utility grades ('A', 'B', 'C', 'D', or 'NS') based upon agreement of three methods (peak Cs-137, horizon Cs-137, and Pb-210) to date the cores. Seventy of the 121 cores were graded 'A' or 'B' indicating good correlation of sedimentation rates and interpretable cores. Given that 70 cores have been objectively demonstrated in peer-reviewed literature as reliably amenable to dating, the authors of the Step 2 Geochemical Evaluation should explain the basis for selecting only 20% of those cores.
9. **Page 2-8, Third Paragraph.** The text states that three core locations were selected to represent the LPR from river mile (RM) 1 to RM 7; however, only two locations (cores 241 and 272) were listed. This should be corrected or explained.
10. **Page 2-9, First Paragraph.** The analyte concentrations were linearly interpolated to estimate the 1963 concentration. Given that the segments were homogenized for analysis, the estimated concentration may include decades of sedimentation. For example, when using the average sedimentation rate of 8.2 cm/year for Core 222, the 2.9-foot segment containing the 1963 horizon contains 11 years of sedimentation. Although this method estimates the concentration at an approximate time period, the coarse segmentation for the dataset imparts uncertainty on results of the 1995 to 1963 comparison.



- 11. Page 2-10, First Paragraph (partial).** The assessment caveats the ratio analysis, indicating that specific contaminant ratios remain consistent regardless of distance or dilution, "*assuming that a secondary source has not contributed another signature.*" . As previously stated, other sources could contribute another signature; but, more importantly, what about similar process sources that contribute similar signatures? This assessment ignores the fact that more than one source exists for many, if not all, contaminants in this waterway, including DDT and 2,3,7,8-TCDD.
- 12. Page 2-10, First Full Paragraph.** The locations containing non-detected or rejected metal results for the nine metals specified were removed from the metal source characterization. Removal of these locations can bias the results. For example, core 210 did not contain data for silver; however, this core had elevated concentrations for both mercury and arsenic (8.3 mg/kg and 35.6 mg/kg, respectively). The Step 2 Geochemical Evaluation should state the potential bias from this analysis when presenting the evaluation's conclusions.
- 13. Page 2-12, Table 2-6.** The difference between the "Sediments Classified as Recent, Fine-Grained" and "Sediments NOT Classified as Recent, Fine-Grained" is not distinct. For example, "dark brown silt" is considered recent, but "brown silt" is not recent. As the classification of sediments was used to compute the volume of recent, fine-grained sediment, a difference in professional judgment of sediment classification could skew the volume computation. The authors should state clearly the method used to determine which sediments are considered to fall into the category of "recent."
- 14. Page 2-14, Third Paragraph.** The text states that missing core segments were replaced with linearly interpolated or adjacent segment (i.e., segment above or below missing segment) data. Information should be provided indicating specifically where and how often this data replacement occurred. In addition, missing data from the uppermost layer of the core was assigned the value of the layer below. This could significantly bias-high the results since, with few exceptions, less contaminated sediments overlay more contaminated sediments.
- 15. Page 2-17, Third Paragraph.** Although using sediment type to constrain polygonal declustering provided a starting point for determining sediment MPA, several unrealistic polygon units were produced (see Figures 5-2 through 5-5). Using the river geomorphology to determine selection of the polygons should be considered as it may reduce irregularities in the polygons and provide a better representation



of the sediment types and contaminant distributions (see Overarching Comment 3). Discussion of this consideration, and its outcome, should be included in the report.

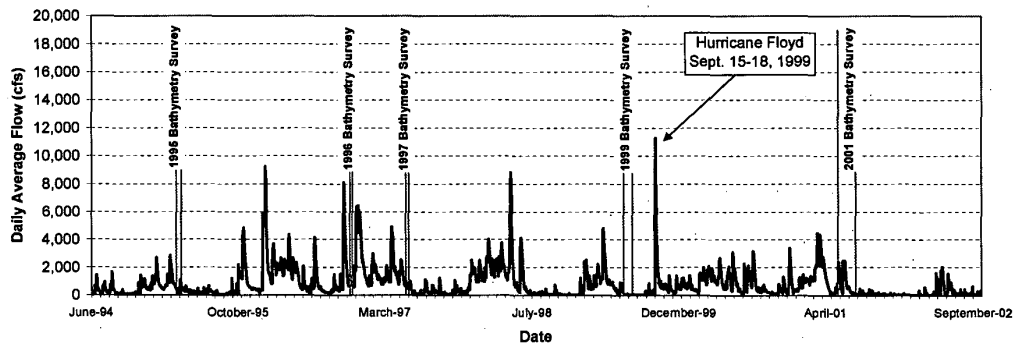
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- 16. Page 3-2, First Full Paragraph.** In the first (partial) paragraph on this page, the authors cite a bathymetric comparison between 2002 and 2001 that resulted in a loss of 166,000 cubic yards (cy) of sediment. They suggest that “...large swings in accumulation estimates are coincidentally associated with changes in surveying company...” In the next paragraph, for the same year-span, and using results from the same two surveying companies, the authors show a gain of 5,870 cy. This results in a difference of nearly 172,000 cy of sediment. The discrepancy appears to be in the data manipulations rather than attributable to changes in reputable surveying companies. As proposed in Specific Comment 4 to the Step 2 Geochemical Evaluation, the authors should use the methods presented by Herzog and Bradshaw (2005) to develop uncertainties to accompany the presented results.
- 17. Page 3-2, Second Full Paragraph.** The conclusions regarding net erosion of the bed are not supported and should be removed. For example, how can the authors conclude that “erosion probably occurred” between 2001 and 2004 when the stated uncertainty is  $\pm 46,000$  cy? Similarly, isn't it possible that what is described as the 1996/1997 “erosional” event was in fact depositional? Daily average freshwater flows in the Passaic River from June 1994 through 2002 are presented in the figure below, along with the dates of the bathymetric surveys. As shown, several high flow events occurred between the surveys. Table 3-2 of the Step 2 Geochemical Evaluation indicates an annual accumulation of 165,000 cy between 1995 and 1996, and 68,800 cy between 1999 and 2000. As shown on the figure below, high river flows occurred between both these events (including a high-flow event immediately preceding the 1996 survey and another high-flow event at the time of passage of Hurricane Floyd in 1999). This would suggest that these events did not have a significant destabilizing effect on the sediments (net deposition occurred). It also suggests that the erosion reported based on the 1996 to 1997 survey comparison is likely a function of the uncertainty of the estimate. The bathymetric comparisons clearly indicate that the LPR is net depositional and that there are broad areas that exhibit long-term accumulation and stability.

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**Passaic River Daily Average Flows at Little Falls, NJ  
1994 - 2002**



- 18. Page 3-2, Last Paragraph.** Sampling uncertainty should not be attributed to the bathymetric sounding equipment used by Tierra's contractor. The equipment and procedures used in 1995 are identical to the equipment and procedures used in 1996 and thereafter. As discussed in Specific Comment 4 to the Step 2 Geochemical Evaluation, Herzog and Bradshaw (2005) present a method for computing uncertainty that should be considered for these computations.
- 19. Pages 3-3, 3-4, and 3-5.** There is a significant potential disconnect between the calculated annual sedimentation rate in the LPR, and the anticipated or suggested solids loading to Newark Bay. On page 3-3, the Step 2 Geochemical Evaluation states that the average sedimentation rate in the lower 7 miles converges on 1 to 2 inches/year overall. On page 3-4 it states that, based on Lowe et al. (2005), total solids loading to the lower 15 miles is approximately 79,000 cy/year, 67,000 of which settles out before reaching Newark Bay (based on 1989/2004 bathymetric comparison). Of this 67,000 cy estimate, 59,000 apparently settle in the lower 7 miles, which equates to roughly 1.33 inches per year. The Step 2 Geochemical Evaluation concludes that 12,000 cy disperse from the Passaic River to Newark Bay. Questions/concerns that emerge from this analysis include the following:

- Pages 3-4 and 3-5 acknowledge the potential significant uncertainty associated with both annual solids loading to the LPR and the rate of deposition. Despite this, the Step 2 Geochemical Evaluation seems to readily accept the 12,000 cy/year loading to Newark Bay. It is entirely possible that the loading from upstream sources is less, and the depositional value is greater, thereby producing the plausible scenario that all of the solids settle out before reaching Newark Bay.
- Assuming that the 79,000 cy/yr LPR loading estimate is accurate, this volume would equate (according to the methodology used in the report) to approximately 1.76 inches of accumulation in the lower 7 miles. This depth of accumulation is well within the average sedimentation rate provided on page 3-3 of between 1 and 2 inches, thereby implying that it is entirely possible that all of the solids emanating from upstream settle out in the lower 7 miles before reaching Newark Bay.

**20. Page 3-4, First Full Paragraph.** Malcolm Pirnie states *"The difference between the Lowe et al. value and the bathymetric net deposition value is approximately 12,000 cubic yard/year, representing the annual solids load from the Lower Passaic River to Newark Bay. This calculation contradicts the conclusion by Huntley et al. (1991) [sic], who examined select radiological data and concluded that sediments from the Lower Passaic River were not being transported to Newark Bay."* This statement is incorrect. Huntley et al. (1995) (emphasis added; note the date of the article was incorrectly stated) supported conclusions previously stated by Suszkowski (1978) and Olsen et al. (1984) that relative to other sources to Newark Bay, the Passaic River is a smaller contributor of sediment. See specific quote from Huntley et al. (1995) below.

*"The high rate of sediment deposition in the lower Passaic River and previously reported hydrodynamic data suggest that the lower Passaic River is not likely to be a major contributor of sediment to Newark Bay."*

The text should be corrected in the Step 2 Geochemical Evaluation.

**21. Page 3-5, First Full Paragraph.** This summary paragraph appears to suggest that geochemical data provide an independent line of evidence supporting the sediment transport/mass balance conclusions presented in Section 3.3. The rationale is that because peak concentrations of dioxin in the Hudson-Raritan estuary, Newark Bay, and the Passaic River are consistently found in sediments

dating to the 1950s and 1960s, that geochemical data support the sediment transport conceptual model. This paragraph fails to note that the occurrence of maximum concentrations of virtually any chemical – in virtually any industrialized U.S. waterway – would likely be observed in sediments deposited in the 1950s and 1960s.

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The post World War II economic boom resulted in rapid industrial growth and an increase in point source discharges to industrialized waterways across the nation. Heightened environmental consciousness in the 1960s ultimately resulted in legislation such as the Clean Water Act of 1972, which resulted in point source controls and the institution of total maximum daily loads (TMDLs). This had the effect of sharply reducing discharges in waterways across the nation, beginning in the 1970s. As a result, the default expectation in the investigation of any industrialized waterway is that the highest concentrations of chemical contaminants are found in sediments deposited in the 1950s and 1960s. If such an expectation is warranted anywhere, it is certainly warranted in the Hudson-Raritan estuary, Newark Bay, and the Passaic River. The observations outlined in the final paragraph of Section 3.3 hardly constitute an independent line of evidence to support the solids mass balance estimates presented in Section 3.3 or to suggest a single source of PCDD to the estuary that is not substantiated.

Accordingly, this summary paragraph needs to be qualified with appropriate wording to reflect the foregoing considerations.

22. **Page 3-5, Second Bullet.** This statement needs to be corrected based on the aforementioned issues related to the inaccuracy of the authors' analysis.
23. **Page 3-5, Third Bullet.** This statement needs to be corrected based on the aforementioned issues related to the inaccuracy of the authors' analysis.
24. **Page 3-5, Last Bullet.** It is unclear how the authors arrived at an estimate of 20% to 50% of upriver solids eventually being transported out of the LPR. References for all input values used in calculations should be provided and the calculation should be explained. In addition, the authors are remiss in omitting from their description of the sediment dynamics in the LPR the net sediment transport from Newark Bay into the Passaic River in the deep estuarine flow field.

- 25. Page 4-1, First and Second Bullets.** These assumptions are overly simplistic, especially when considering the system's geomorphology (see Overarching Comment 3).
- 26. Page 4-1, Seventh Bullet.** This assumption ignores the existing analytical data – point sources appear to create significant local contaminant variations, and sample results vary over very small distances. For example, cores 241, 242, 243, 244, 245, and 14A from the Tierra Newark Bay database contain some of the highest mercury results (>20 milligrams per kilogram [mg/kg]) in the LPR. Cores located just upstream and downstream of this region in the LPR contain relatively lower concentrations (0 to 10 mg/kg).
- 27. Page 4-3, First Full Paragraph.** As discussed in Specific Comment 8 to the Step 2 Geochemical Evaluation, Erickson et al. (2007) concluded that 70 of 121 cores within the LPR were interpretable cores. Using only 14 cores in the analysis of downcore profiles impacts the authors' ability to accurately describe the system's complexities. Additionally, the criteria used to select these 14 cores should be described.
- 28. Page 4-3, Last Paragraph.** Consistent with the body of evidence maintained by USEPA for the Site, there exist local sources of these discussed hazardous substances proximate to the observed sample locations.
- 29. Page 4-5, First Bullet.** As described above, the selection criteria for the 14 cores are not presented in the Step 2 Geochemical Evaluation (see Specific Comment 8 to the Step 2 Geochemical Evaluation). Therefore, the conclusion "*No significant historical loadings are indicated in the aldrin data since this chemical was reported as nondetect in all 14 dated sediment cores examined*" may not be accurate. This needs to be re-evaluated after, and in connection with, presentation of the pertinent selection criteria.
- 30. Page 4-6 to 4-7, Section 4.3.4.** In this section the author calls on the arguments of Bopp et al. (1991) who first advanced the idea of using DDT as a co-contaminant tracer for 2,3,7,8-TCDD. Bopp's rationale was that in one Newark Bay dated core where the sediment chronology was established through Cs-137 dating, the peak concentration of p,p'-DDD (a degradation product of DDT) was observed in pre-1954 sediments and the peak concentration of 2,3,7,8-TCDD was observed in highest concentrations in mid 1960s sediments. Bopp et al. (1991) noted that these dates were consistent, respectively, with dates of peak DDT and 2,4,5-T

production at the 80 Lister Avenue Site, located along the LPR. Thus, Bopp concluded that the dioxin and DDT data in Newark Bay were consistent with a predominant 80 Lister Avenue source.

Here, the authors claim to have tested Bopp's theory by analyzing contaminant profiles in dated cores from Tierra's 1995 Passaic River RI/FS. Based on that analysis, the authors reached the following conclusions.

- *"this review confirms that Total DDT is found at greater depths than 2,3,7,8-TCDD."*
- *"Total DDT and 2,3,7,8-TCDD have similar release histories as documented by Bopp et al., (1991)."*

These conclusions are invalid for the reasons explained below.

The authors first identified 14 cores for which there were reliable sediment chronologies based on interpretable Cs-137 profiles (see discussion, under Specific Comment 8 to the Step 2 Geochemical Evaluation, on criteria used to choose these cores). Of those 14 cores, the authors concluded that two cores did not exhibit *"consistent chemical profiles (TSI locations 248 and 251), suggesting that the location had been disturbed in the mid-1950s."* In the context of Bopp's DDT/TCDD chronology argument, this age range is important, because it is within the range of Bopp's early 1950s predicted maximum for DDT and his predicted 1960s maximum for 2,3,7,8-TCDD. Given this caveat, only 12 cores analyzed by the authors presented internally consistent Cs-137 chronologies and chemical profiles.

The downcore profiles for Cs-137, total DDT, and 2,3,7,8-TCDD are included by the authors on Figures 4-5a through 4-5n. Of the 12 cores judged to have *"internally consistent chronologies"* less than half show the contaminant chronology predicted by Bopp. Only five cores (Cores 209, 230, 235, 241, and 275) exhibit the DDT peak in the early 1950s and a 2,3,7,8-TCDD peak in the 1960s. Five other cores show these two chemicals peaking in exactly the same sample, and two of the 12 cores show the exact **opposite** of what Bopp predicted. Cores 232 (Figure 4-5e) and 296 (Figure 4-5m) clearly show that the maximum concentrations of 2,3,7,8-TCDD predates the maximum concentration of total DDT. This "opposite-of-predicted" contaminant chronology in Core 232 is particularly noteworthy because it was collected in the Harrison Reach of the LPR, very near the 80 Lister

Avenue Site (see Figure 2-1). If there is any place in the study area that one would expect Bopp's prediction to consistently hold, it would be in cores from the Harrison Reach.

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In summary, the DDT and 2,3,7,8-TCDD depth profiles presented by the authors (Figure 4-5) clearly illustrate that Bopp's predicted DDT/TCDD chronology is not consistently observed, even in LPR cores near the 80 Lister Avenue Site. This suggests the existence of multiple sources of one or both of these analytes. This suggestion is consistent with the body of evidence maintained by USEPA for the Site.

- 31. Page 4-7, Second and Third Paragraphs.** In this section, the authors summarize 2,3,7,8-TCDD data in context of the 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio proposed by Chaky (2003). The rationale for Chaky's ratio argument and the flaws in his logic are summarized in detail, above, in Specific Comment 15 to the Preliminary Geochemical Evaluation. In summary, the data presented by Chaky are insufficient to support the key assumptions that form the foundation of the theory. Certainly, the TCDD ratio has not undergone sufficient scrutiny to be used as a diagnostic fingerprinting tool.

Even if we ignore this caution and take Chaky's theory at face value, the argument of a single source of 2,3,7,8-TCDD does not hold up – even if we limit ourselves to looking only in the LPR. On page 4-7, the authors conclude that the TCDD ratio is consistent and stable, which suggests a single source of 2,3,7,8-TCDD. However, this section of the Step 2 Geochemical Evaluation references Figure 4-6, which shows TCDD ratios with depth in two LPR cores. These profiles clearly show that TCDD ratios decline significantly in the LPR sediments deposited after 1970. Even if one were to suggest a single source of 2,3,7,8-TCDD in the LPR prior to 1970, this decreasing trend in younger sediments clearly implies dilution resulting from mixing with a 2,3,7,8-TCDD source (or sources) with a lower ratio. Thus, Chaky's theory does not support the theory of a single source of 2,3,7,8-TCDD.

- 32. Page 4-9, Second Full Paragraph.** The low concentrations of metals (below background) at the bottom segments of Cores 248 and 251 are explained by the authors as due to a "discontinuity." The authors should explain what is meant by the term "discontinuity." It is conceivable that these cores indicate pre-peak loading at the bottom segments (as the authors suggest) because they both are located within the Federal Navigation Channel limits.



33. **Page 4-9, Bullets.** The bulleted conclusions in this section will need to be revised consistent with the comments provided previously.
34. **Page 4-10, First paragraph, Section 4.4.** As discussed in Specific Comment 8 to the Step 2 Geochemical Evaluation, Erickson et al. (2007) concluded that 70 of 121 cores within the LPR were interpretable cores. The use of only 14 cores in the analysis of surface sediment concentrations likely minimizes the authors' ability to accurately describe the system's complexities. Additionally, the criteria used to select these 14 cores, which account for only 20% of the potentially dateable cores, should be described.
35. **Page 4-10 to 4-12, Section 4.4.1 – Trends in Surface Sediment Concentrations.** In Section 4.4.1, the authors used a statistical test (Mann-Kendall) to test the hypothesis of a geographical trend in surface sediment concentrations. Using the 1995 RI/FS data, Mann-Kendall was used to test a null hypothesis of no trend versus two separate alternative hypotheses:
- increasing trend in concentrations downriver; and
  - decreasing trend in concentrations downriver.

This test was run for nine inorganic analytes, total PAHs, TPH, 2,3,7,8-TCDD, and total PCBs. For the vast majority of chemicals tested, the authors concluded that there was "No Trend."

The use of the Mann-Kendall test, in and of itself, is not an unreasonable approach. However, the authors' conclusions are unsupportable and defy logic. Mann-Kendall allows for a formal test of the theory that chemical concentrations increase as one moves upstream or downstream along the Passaic River. Upon seeing a predominant "No trend" result, the authors concluded that "[The fact that *n*]o concentration trend [is exhibited] suggests that solids load in the Lower Passaic River is well mixed prior to deposition. No evidence exists for more than one source" and "most of the contaminants examined have no trend, yielding no evidence to suggest multiple sources." These statements are remarkably unsupportable. Failure to reject the null hypothesis (and thus concluding "no trend") could easily result from the presence of multiple sources under consideration of minimal mixing/homogenization of surface sediment concentrations up and down the LPR. Under those conditions, one would expect to encounter multiple areas of high concentration in surface sediments, with each of



them located near a source. Clearly, given such a scenario, there would be no monotonic trend as one moved either upstream or downstream.

It appears the authors' ill-founded conclusions may be predicated upon the *a priori* assumption of a single source, with the complete and total mixing/homogenization theory tacked on at the end to rationalize the predominant "no trend" findings resulting from the Mann-Kendall test. As suggested, there are multiple feasible scenarios that would explain a "no trend" result, particularly in an area such as the LPR with its high population density and long industrial history.

In summary, it is simply not credible to suggest that the results of the Mann-Kendall test prove that the surface sediment concentrations of these chemicals are attributable to only one source.

- 36. Page 4-14, First Full Paragraph.** The Step 2 Geochemical Evaluation should qualify the findings regarding potential sources, both above and just below the Dundee Dam, in a way that acknowledges the relatively small underlying dataset. It is widely recognized that little data exist in this region of the Passaic River, including the 11-mile stretch extending downstream of the Dundee Dam. Tierra supports the collection of additional sediment data to better represent conditions in this area.
- 37. Page 4-15, First and Second Paragraph.** These conclusions are not based on sound science. Classic river geomorphology (see Overarching Comment 3) identifies this area as a depositional environment for upstream, and perhaps downstream, tidal-driven sediments. A depositional environment within an urban waterway is a highly logical explanation for the observed contaminant concentrations.
- 38. Page 4-16, Fourth Bullet.** The conclusions regarding the homogeneity of metals being indicative of tidal mixing ignores the potential impact of CSO discharges and sewer system bypasses, which may distribute the contaminant load.
- 39. Page 4-19, Second and Third Paragraphs.** The argument regarding fingerprinting total DDT using the ratio of 2,4'-DDT to the sum of all isomers is confusing and it is difficult to determine what the authors are concluding. The text states "*The major releases of Total DDT to the Lower Passaic River are alleged to*

*be the result of DDT manufacture and not agricultural application.” and “...the ratio of 2,4'-DDT to the sum of all isomers usually averages around 0.25 for agriculturally applied DDT (MacGregor, 1974).” Based on the surface sediment samples collected in 1993, a ratio of 0.20 was computed for the LPR, which the authors state is “consistent with the commercial composition of DDT that is applied agriculturally.” Is it the authors’ conclusion that the ratio of 0.20 is indicative of agricultural runoff? This subjective conclusion should be clearly stated and substantiated.*

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**40. Page 4-19 to 4-22, Section 4.5.3 – PAH Source Analysis.** The authors misrepresent the application of source evaluation techniques (i.e., use of double ratio plots) presented in Costa and Sauer (2005) in evaluating the potential sources of PAHs in the LPR, and therefore misinterpret the likely primary sources of PAHs in the LPR. The authors’ misrepresentations and misinterpretations are described below:

- The representations of the PAH sources (circled data clusters) in Costa and Sauer (2005) were specific to the site-specific sources presented for illustrative purposes and are not representative of PAH sources for all sites or situations. Each site presents conditions and sources with PAH characteristics that are generally site specific. Costa and Sauer provide diagnostic ratios and double ratio plots that empirically help to differentiate sources of PAH at a particular site, and provide examples of their usefulness in distinguishing some common PAH source types. The evaluation in Costa and Sauer (2005) demonstrates that some PAH compositional characteristics are widely applicable; but more importantly, site-specific PAH characteristics need to be determined empirically when evaluating potential site-specific sources. Costa and Sauer’s purpose was to illustrate useful diagnostic ratios and interpretative techniques in evaluating potential sources, rather than provide reference ratio values for various PAH source types.
- The representations of “typical coal tar signature” and “typical urban background” PAHs on Figure 4-22 (circle) of the Step 2 Geochemical Evaluation, attributed to Costa and Sauer (2005), are misleading and over simplified.

The circled data points in the double ratio plots of Costa and Sauer (2005) represent the coal tar generated from the carbureted water gas (CWG) process in gas manufacturing, which is one of several different

processes employed by manufactured gas plants in the northeast U.S. between the late 1800s and 1950s. The PAH ratios of CWG coal tar are specific for the site presented in Costa and Sauer (2005). The fluoranthene/pyrene (F/Py) ratio for CWG coal tar at other sites can range considerably more than the circle in the double ratio plots in Costa and Sauer (2005), as reproduced (circle) in the plots of the Preliminary Geochemistry Evaluation.

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Accordingly, the circle on Figure 4-22 representing "typical coal tar signature" is not "typical" for all coal tars. There are other types of coal tar produced from other manufacturing gas processes, such as coal carbonization, which was used historically by former MGPs along the LPR. Coal tar from the coal carbonization process has F/Py ratios that are typically greater than 1.0, and within the range for PAHs from "background" combustion sources.

Because there are coal tars with different PAH characteristics, the attribution of results within the "Typical Urban Combustion-Related Background Signature" ellipsoid on Figure 4-22 is potentially incorrect because PAHs from coal carbonization process tars may have similar PAH signatures as those samples within the 'background' region of the plot. As a result, further evaluation of the PAH data to determine whether the PAHs are from background or from coal tar is warranted.

This error relating to generalization by the authors about "typical urban background signature" is further exacerbated on Figure 4-23 where all samples with F/Py ratios greater than 1 are attributed to "typical urban background." Considering the total PAH concentrations of some of the samples and the known history of coal tar generation in the LPR, the attribution of these samples simply to "typical urban background" sources is very misleading and with significant potential of being incorrect.

- 41. Page 4-21, First Paragraph.** The statement regarding subsurface PAH concentration trends "*Because of these temporal trends, a weak relationship exists between the Total PAH concentrations and core depth as depicted by the weighted curve in Figure 4-20*" is misleading. PAH trends in subsurface sediments in the LPR may be confounded by several factors, including mixing of multiple sources as well as temporal differences in source loadings. Elevated PAHs at depth are likely

associated with point sources, specific areas of the Passaic River where there are elevated inputs, and different sources of PAHs. The cores should be evaluated individually and then, at a minimum, segregated spatially according to location along the Passaic River, or grouped according to specific areas of the Passaic River with common PAH characteristics.

**42. Page 4-21, Second Paragraph.** The PAH data are discussed in relation to high-molecular-weight (HMW) PAHs using Figure 4-21 as a discussion point. Several observations are presented without any apparent interpretation or conclusion, for example:

- What is the significance of only 10 of the 495 samples having a "Ring456/Total PAH" ratio less than 0.5, other than that "the lower molecular weight PAH composition was greater than the HMW PAH composition..."?
- Also, what is the significance of the HMW PAH concentration accounting for 81% of the total PAH concentration?

**43. Pages 4-21 Last Paragraph and 4-22.** The authors perform PCA on the 16 priority pollutant PAH dataset and use the PCA results to discuss the variance of the data. The analysis raises several questions that are not answered, including:

- What is the significance of the variances in PC1, PC2, and PC3? How do the PCA variances highlight that petrogenic and combustion sources are present in the system? It is obvious from PAH compositions that the sediments contain PAHs from combustion sources. With the PCA of the 16 priority pollutant PAHs alone, variances cannot reliably be attributed to petrogenic sources. Fairly fresh coal tar residuals contain large proportions of 2- and 3-ring PAHs, accounting for about half of total PAHs (16 priority pollutant PAHs). Thus, variances in PCAs may be due to weathering of coal tar or coal tar products that may change the relative amounts of HMW PAHs in the sediment. The PCA analysis does not provide the most reliable evidence for combustion and petrogenic sources of PAHs in the river sediments.
- It is unclear what is meant by the statement, "*petrogenic sources were evident in the Lower Passaic River sediment with TPH concentrations in surface sediment ranging from 100-1000 mg/kg.*" Are the authors concluding that TPH values from 100 to 1,000 mg/kg are indicative of petrogenic sources? Although TPH is an acronym for "total petroleum hydrocarbons," the TPH

value includes the contribution from other hydrocarbons in addition to petroleum hydrocarbons, such as coal, coal tar, combustion products, natural plant material, etc. In the case of coal tar and coal tar products, PAHs make up approximately half of the TPH content. Because total PAH concentrations in sediment from coal tar sources can be in the thousands of mg/kg, TPH values in the 100 to 1,000 mg/kg concentration range may also be explained by the presence of coal tar sources. To determine if petroleum is the principal contributor to TPH, the TPH "fingerprint" (gas chromatograph) should also be examined.

- 44. Page 4-22, First Paragraph.** The significance of *"....the variability explained by PC1 in the current analysis is lower than the PC1 reported in the Preliminary Geochemical Evaluation, which was conducted on surface sediments only..."* should be further explained.
- 45. Page 4-23, First Paragraph.** The authors state that *"Three observations suggest that Newark Bay sediments are not being transported into the Lower Passaic River at any significant scale..."* Measurements in the Passaic River indicate that sediment is being transported into the Passaic River from Newark Bay due to estuarine circulation patterns (density-driven stratification and circulation). Suszkowski (1978) suggested that sediments are brought back to the LPR along with sediments from downstream sources by the net upstream flow of bottom waters. Also, hydrodynamic measurements by Rutgers University in 2005 indicated the presence of an Estuarine Turbidity Maximum (ETM) in the LPR. The ETM occurs in estuarine systems at the convergence of deeper saline water with fresh surficial water. Sedimentation is locally enhanced in the area where the ETM is present. The authors' conclusion is an unsupported oversimplification of sedimentation and transport in the LPR, and the statement should be removed.
- 46. Page 4-24, Table 4-6.** The number of samples included in the surface concentration calculation for 2,3,7,8-TCDD in Arthur Kill is missing.
- 47. Page 4-24, Second Paragraph.** The first paragraph of Section 4.6.1 indicates that the foundation of the Mass Balance Model is predicated on the validity of the 2,3,7,8-TCDD/ $\Sigma$ TCDD ratio. Earlier we discussed problems with the Chaky ratio (See Specific Comment 14 to the Preliminary Geochemical Evaluation and Specific Comments 30 and 31 to the Step 2 Geochemical Evaluation). Thus, to the extent that the reliability of the ratio is in question, the reliability of any mass

balance calculation that assumes that the ratio is “*well known throughout Newark Bay area...*” is in serious doubt.

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- 48. Page 4-24, Second Paragraph.** The objective of the sediment budget analysis presented in Lowe et al. (2005) was to close a solids mass balance, solving for the marine-side solids loads (i.e., inputs to Newark Bay from Arthur Kill and Kill van Kull). There is no discussion in the text regarding the effect on mass balance calculations of the estimated maintenance dredging volumes. Lowe et al. (2005) allude to the difficulty in interpreting historical USACE and Port Authority dredging records, but no attempt was made to estimate or quantify the level of uncertainty associated with this estimate. For example, the annual dredging volume was estimated at 161,680 cubic meters/year ( $\text{m}^3/\text{yr}$ ). However, the annual maintenance dredging ranged from 0 to 1,070,000  $\text{m}^3/\text{yr}$ . This is a significant range that is not indicated by the reported average. This uncertainty propagates into the mass balance calculations.
- 49. Page 4-28, First Paragraph.** The authors acknowledge the data gap of combined sewer overflows/wastewater treatment plants' (CSOs/WWTPs) discharges of mercury and 2,3,7,8-TCDD, yet they conclude “...*the contributions by CSO/WWTP discharges to the 2,3,7,8-TCDD balance are unlikely to be large.*” The authors support this statement with an example from only one WWTP. This data gap should be resolved prior to recomputing the mass balances.
- 50. Page 4-29, First and Second Bullets.** The conclusions presented by the authors resulting from the mass balance analysis are stated without acknowledging the uncertainty associated with them. The mass balance was based on estimates of solids loadings with a large amount of uncertainty and, subsequently, this uncertainty is propagated through the calculation. The statements such as “...*solids from the Lower Passaic River comprise approximately 10 percent of the total amount of solids accumulating in the bay*” and “...*that currently more the 80 percent of the 2,3,7,8-TCDD accumulating in Newark Bay must originate in the Lower Passaic River*” are presented as facts. Bounding estimates for these calculations should be provided before any conclusions are drawn.
- 51. Pages 4-30 and 4-31, Section 4.7 – Water Column and Biota Evaluations.** There does not appear to be a clear data use for the calculation and evaluation of contaminant ratios in biota, particularly given their variability among species. Fingerprinting in biota has not proven to be successful in the past, primarily because of the large number of uncertainties such as species variability in uptake

rates, food web interaction differences by waterway, physiological stress and state differences by waterway or region, seasonal differences in behavior/physiology, food source differences by season/waterway/sub-waterway/salinity zone, etc.

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- 52. Page 4-31, Last Paragraph.** The conclusion presented that "...contaminants that were characteristic of the Lower Passaic River sediments were detected in biota samples, indicating the likelihood of ongoing biological impacts from the contaminated sediments" clearly assumes that the sediments are the source of the contaminant loads in biota. If those contaminants are present in soluble form in the water, then that would likely be a greater source than the sediment bed. The absence of water chemistry data is a major and well-known data gap. Therefore, the associated uncertainty must be acknowledged. The above-stated conclusion should be revised accordingly.

The authors note: "*The ratio in mummichogs and white perch was close to 1, similar to, but higher than the typical range of the ratio observed in the sediments.*" Yet, this reflects a nearly 50% increase from the often cited 0.7 ratio. It is highly misleading to claim that a value that is 50% higher than a benchmark is "similar."

The authors do not discuss how the variability in tissue concentrations of the dioxins/furans affects the average ratios that are being calculated. In addition, there is no explanation provided for the interspecies difference.

- 53. Page 5-1, Second Paragraph.** The authors state that "*The analysis assumes the recent, fine-grained sediments thickness is approximately equal to the thickness of contaminated sediment.*" However, it is evident in the downcore profiles that concentrations of various contaminants are attenuating. Thus, it should be stated by the authors that this volume computation likely overestimates the volume of contaminated sediments.

- 54. Page 5-3, First Paragraph.** The observation "...the data exhibit a great deal of short-range heterogeneity, that is, high contaminant inventory areas are often found immediately adjacent to low inventory areas..." conflicts with previous statements (see page 4-1, seventh bullet, and Specific Comment 26 to the Step 2 Geochemical Evaluation herein), which suggests homogenous contamination patterns due to tidal mixing. Furthermore, this observation is inconsistent with the conclusion (page 5-8, sixth bullet, and Specific Comment 59 to the Step 2 Geochemical Evaluation herein) that states "hot spots" do not exist.



**55. Page 5-7, First Paragraph.** The authors do not provide a basis for using factors of 25% and 100% to increase the sediment inventory. Further, they assume that the added mass has a contaminant concentration equal to the mean for the category. Again, no scientific basis is provided for this arbitrary decision. Both the use by the authors of these compounding conservative and unsubstantiated assumptions, as well as the resulting impact of substantially increasing the calculated mass of contaminated sediment in the LPR, should be expressly acknowledged by the authors in the report.

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**56. Page 5-8, Sixth Bullet.** The authors state *"the coring data indicates a high degree of spatial heterogeneity, suggesting that localized areas of relatively higher concentrations typically described as 'hot spots' do not exist. Instead, 'hot' regions of the river typically exist on the scale of a mile or more, nearly bank to bank in lateral extent."* It is uncertain if the MPA calculations were used to draw this conclusion. The low spatial density of the cores results in polygons that nearly span the entire width of the river. Thus, the associated MPAs span the "bank to bank" extent of the river, and may overestimate the "hot regions." Additionally, the MPA computation is a function of both the concentration within the core and sedimentation (i.e., sediment thickness). Therefore, a core containing a high concentration segment several feet below the sediment surface can have an MPA similar to a shallow core with a high surface concentration.

**57. Page 5-9, Last Paragraph.** As discussed in General Comment 5 to the Step 2 Geochemical Evaluation, it is not clear why the authors focused on developing volumes as part of this analysis. Calculating contaminated sediment volumes and MPA to represent contaminant inventories implies a pre-determination of a dredging remedy. Mass and volume estimates should instead be calculated as part of the FS process, where dredging is evaluated as one of **several** alternatives for the site. Accordingly, this exercise should be postponed to the FS stage, by which time the many other technical flaws in the Step 2 Geochemical Evaluation may have been addressed. Additionally, it should be noted that the volumes presented within the Step 2 Geochemical Evaluation are *in situ* values and, therefore, are not suitable for forecasting removal volumes.

**58. Page 6-1, First Paragraph.** The authors state that *"The geochemical evaluation presented in this document forms the basis for an important series of conclusions and observations regarding the complexities of the Lower Passaic River as well as the usefulness of the existing database to describe the river."* As previously commented, it is difficult to draw conclusions from calculations with such a high



degree of uncertainty or that are based on unsubstantiated assumptions. These calculations, when performed properly, should identify data gaps that must be filled to adequately support the future FS.

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